

Two new lichens from Mount Canobolas, New South Wales

Patrick M. McCarthy¹ and John A. Elix²

¹*Australian Biological Resources Study, GPO Box 787, Canberra, A.C.T. 2601, Australia*
patrick.mccarthy@environment.gov.au

²*Research School of Chemistry, Building 137, Australian National University, Canberra, A.C.T. 0200, Australia* john.elix@anu.edu.au

Abstract

Gyalideopsis halocarpa sp. nov. (lichenized Ascomycota, Gomphillaceae) and *Sarcogyne sekikaica* sp. nov. (lichenized Ascomycota, Acarosporaceae) are described from the summit area of Mount Canobolas, an important lichen site near Orange in eastern New South Wales, Australia.

Introduction

Mount Canobolas State Conservation Area is an isolated outlier of the Great Dividing Range supporting one of the largest remnants of subalpine vegetation in the central west of New South Wales (Central Tablelands: sensu Anderson 1961, Jacobs and Pickard 1981).

Most of the plant communities are at the north-western limit of their known distribution and some are highly significant. The Mount Canobolas *Xanthoparmelia* Lichen Community has been listed as an Endangered Ecological Community under the New South Wales *Threatened Species Conservation (TSC) Act 1995*, the only lichen community in Australia with such legal recognition. *Xanthoparmelia metastrigosa* (Elix) Hale is known only from Mount Canobolas, while *X. sulcifera* (Kurok.) Hale is known from one other locality in the State. Other unusual species growing on the mountain include *X. canobolasensis* Elix, *X. willisii* (Kurok. & Filson) Elix & J.Johnst. and *Cladia fuliginosa* Filson, each known from only one other locality in New South Wales.

A brief, intensive foray to the summit of Mount Canobolas in April 2014 saw the discovery of two undescribed lichens of the genera *Gyalideopsis* Vězda (Gomphillaceae) and *Sarcogyne* Flot. (Acarosporaceae). Here, the new species are described, illustrated and discussed. An identification key to *Sarcogyne* in Australia is provided.

Methods

Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci and ascospores were made on hand-cut sections mounted in water and dilute KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Chemical constituents were identified by thin-layer chromatography (Elix and Ernst-Russell 1993), high-performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples.

Taxonomy

Gyalideopsis halocarpa P.M.McCarthy & Elix, **sp. nov.** Fig. 1

MycoBank No.: MB809821

Thallus epilithicus, diffusus, mediogriseus vel viridigriseoniger, 0.05–0.1(–0.2) mm crassus. Apothecia superficiales, viridiater vel griseoater, concava vel plana, (0.20–)0.28(–0.34) mm diametro. Excipulum persistens, 40–70 µm crassum, non carbonaceum, pallide halonatum. Hypothecium 10–15 µm crassum, incoloratum. Hymenium 80–100 µm crassum, non inspersionum, non amyloideum. Paraphyses anastomosantes, uniformiter 0.8–1.5(–2) µm crassae. Asci anguste vel late clavati aut ovati, (4–)8-spori, 58–80 µm longi, 18–30 µm lati. Ascospores hyalinae, submuriformes vel muriformes, (17–)23(–28) µm longae, (10–)13(–16) µm latae.

Type: AUSTRALIA. NEW SOUTH WALES: CENTRAL TABLELANDS: Mount Canobolas State Conservation Area, summit of Mt Canobolas, c. 13 km SW of Orange, 33°20'40" S, 148°58'56" E, alt. c. 1390 m, on old horizontal mortar slab in exposed heath, *P.M. McCarthy 4318*, 1 Apr 2014 (holotype: CANB; isotype: HO, NSW).

Thallus crustose, epilithic, usually diffuse and indistinct, commonly threading between sand-grains on the substratum or forming inconspicuous colonies 1–3 mm wide, dull medium grey to dark greenish grey, irregularly granulose to contorted-verruculose, continuous or sparingly rimose, 0.05–0.1(–0.2) mm thick, ecorticate, but with the 10–15 µm thick uppermost zone dark greyish brown in section. Algal cells chlorococcoid, 12–20(–26) µm diam.; interstitial hyphae short-celled, 2–3 µm thick. Prothallus not apparent. Apothecia numerous, solitary and scattered, or paired, or in clusters of 3–6, superficial, adnate to sessile and constricted at the base, biatorine, (0.20–)0.28(–0.34) mm diam. [$n = 50$], in section subtended by a continuous algal layer; disc at first almost urceolate, finally slightly concave to plane, smooth, epruinose, dull greenish black or grey-black, the colour unchanged or somewhat paler when wetted, but not becoming translucent; margin

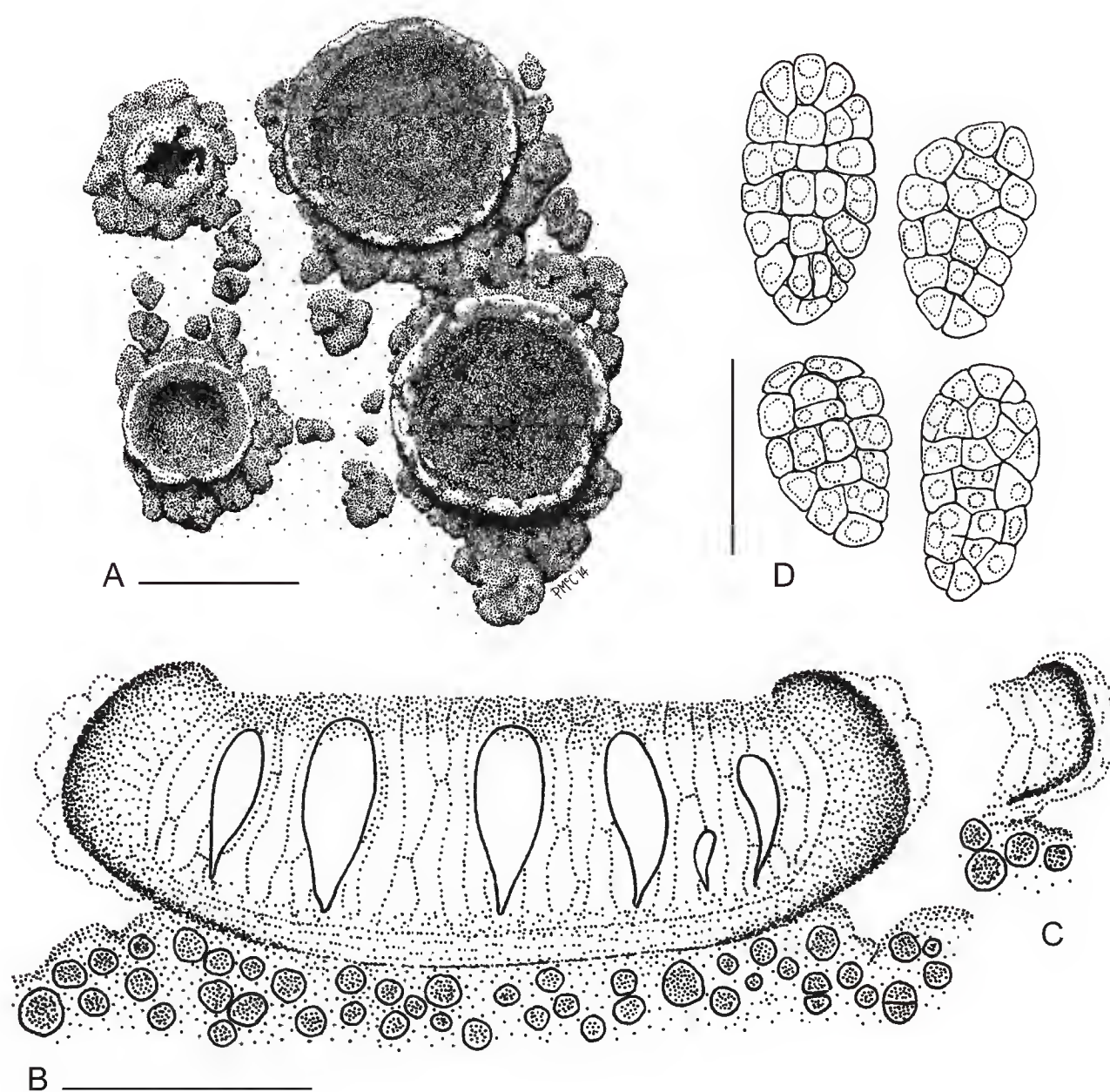


Fig. 1. *Gyalideopsis halocarpa* (holotype). A, Habit of thalli and apothecia; B, Sectioned apothecium and adjacent thallus (semi-schematic); C, Section of immature apothecial margin (semi-schematic); D, Ascospores. Scales: A = 0.2 mm; B, C = 0.1 mm; D = 20 µm.

40–70 µm thick, usually prominent and persistent, with the remnants of the juvenile exciple resembling a pale discontinuous halo against the darker tissues of the margin; in section the proper exciple initially with a continuous, external, hyaline, more or less paraplectenchymatous layer c. 10–15(–25) µm thick, which becomes radially fissured, and later discontinuous and redundant; this is not cortical in origin, the thallus lacking such a structure. Mature exciple dominated by a dark olive-brown, 15–25 µm thick layer of tightly packed, radiating, thick-walled cells 2–4(–5) µm wide, this subtended by and an extension of a loose radiating network of hyaline anastomosing hyphae 20–30 µm thick, all embedded in a gelatinous matrix; in section the dark outer layer of the exciple along with or completely replaced by the paler internal exciple layer are continuous beneath the hypothecium as a well-defined, cellular 15–20 µm thick layer. Hypothecium hyaline, 10–15 µm thick; hymenium 80–100 µm thick; both layers non-amyloid, I– (with or without pretreatment in K); neither layer inspersed with oil droplets, granules or crystals; epihymenial region a diffuse, medium brown, extracellularly pigmented layer 15–25 µm thick. Paraphyses not conglutinate in water, loosening further in KOH, mostly simple towards the base, branching and anastomosing sparingly and mainly distally, 0.8–1.5(–2) µm thick, with cells 5–10 µm long; apical cells not swollen, scarcely pigmented. Asci narrowly to broadly clavate or ovate, (4–)8-spored, 58–80 × 18–30 µm, non-amyloid, with a short tapering stalk; apex rounded; submature asci with a thick tholus and a very broad and elongate, bluntly conical ocular chamber; tholus much thinner at maturity, the ocular chamber collapsing. Ascospores colourless, submuriform to muriform, with 4–7 transverse septa and 2–3(–4) longitudinal or diagonal septa, with 10–15(–20) cells in ocular view, elongate-ellipsoid to broadly ellipsoid or rather irregular, thin-walled, lacking a perispore, (17–)23(–28) × (10–)13(–16) µm [$n = 91$]; cells commonly 1(or 2)-guttulate, the external spore wall constricted at the septa. Hyphophores absent. Pycnidia not seen.

Chemistry: no substances detected.

Gyalideopsis Vězda (Gomphillaceae) is a mainly tropical, foliicolous and corticolous genus of approximately 100 essentially substrate-specific species, less commonly growing on bryophytes, soil, detritus, rotting wood and rock. Seven species are known from Australia, six from bark and rainforest leaves in north-eastern New South Wales and eastern Queensland, and one, *G. graminicola* Vězda & Kantvilas, from a dead *Poa* tussock in alpine grassland in Tasmania (McCarthy 2014); apart from substratum, all seven can be readily distinguishable from *G. halocarpa* by thalline attributes, the presence of hyphophores, the colour, shape and dimensions of the apothecia, and the number, size and septation of the ascospores.

This genus has a chlorococcoid photobiont, biatorine apothecia that range from adnate to stipitate, with an exciple of radiating hyphae in a gelatinous matrix, a non-amyloid hymenium and 1–8-spored asci, thin anastomosing paraphyses and hyaline, transseptate to muriform ascospores (Kalb and Vězda 1988, Vězda 2003, Lücking et al. 2005, 2006). Most taxa on substrata other than rock possess hyphophores that are variously pigmented, stalked or peltate, asexual spore-producing structures that are often diagnostic for species. Indeed, saxicolous species are now uncommon in *Gyalideopsis*, most having been excised to *Lithogyalideopsis* Lücking, Sérus. & Vězda by virtue of their exclusively transseptate ascospores (Lücking et al. 2005, 2006) or to *Diploschistella* Vain. which has immersed apothecia with a thalline rim (Lücking et al. 2005, 2006).

Gyalideopsis halocarpa has a diffuse and rather nondescript calcicolous thallus, minute but highly distinctive apothecia that are blackish but have a strikingly pale excipular halo, asci with (4–)8 comparatively small muriform ascospores, and it lacks hyphophores. The saxicolous *G. subantarctica* Henssen & Lumbsch, from tufa on Prince Edward Island in the South Atlantic Ocean, has blackish brown apothecia with a slightly paler margin, 2–4-spored asci and ascospores 25–55 × 16–28 µm (Henssen and Lumbsch 1985), while *G. lecideina* Kalb & Vězda, from montane siliceous rock in Brazil, has uniformly black, 0.3–0.5 mm wide apothecia and bisporous asci (Kalb and Vězda, 1988). The endemic British lichen, *G. crenulata* Coppins & Aptroot, from siliceous stones in mine spoil, has 0.2–0.3 mm diam. apothecia that are dark brown to black and bounded by a 0.1 mm thick, concolorous crenate margin (Coppins and Aptroot 2008); the persistently submuriform ascospores are smaller than those of *G. halocarpa*.

Etymology: The epithet *halocarpa* is derived from the Greek *halos* [a circle (halo) around the sun or moon] and *karpos* (fruit), in reference to the pale halo-like ring around the blackish apothecia caused by the oldest remnants of the proper margin.

Distribution and habitat: *Gyalideopsis halocarpa* is known only from a very exposed horizontal slab of mortar on the summit of Mount Canobolas (altitude 1390 m) where it grew with an indeterminate sterile species of *Caloplaca*.

***Sarcogyne sekikaica* P.M.McCarthy & Elix, sp. nov.**

Figs 2 & 3

MycoBank No.: MB809822

Thallus epilithicus, determinatus, areolatus, pallidiviridigriseus, 0.1–0.35(–0.45) mm crassus, acidum sekikaicum continens. Apothecia superficiales, olivaceonigra, plana vel valde convexa, (0.36–)0.55(–0.82) mm diametro, saepe albopruinosa. Excipulum tenue persistens aut excludens, 40–70 µm crassum, non carbonaceum, annulatum. Hypothecium 60–100 µm crassum, incoloratum. Hymenium 70–95 µm crassum, non inspersum. Paraphyses ramosae, 2–3.5 µm crassae. Asci clavati vel cylindricoclavati, 40–60(–80)-spori, 58–72 µm longi, 14–18 µm lati, apicibus amyloideis. Ascospores hyalinae, simplices, (6–)7.5(–9.5) µm longae, (3–)4(–5) µm latae.

Type: AUSTRALIA. NEW SOUTH WALES: CENTRAL TABLELANDS: Mount Canobolas State Conservation Area, W face of Mt Canobolas, 13 km SW of Orange, 33°20'17" S, 148°58'37" E, alt. 1250 m, on weathered trachytic rhyolite in heath with scattered *Eucalyptus*, J.A. Elix 46007, 1 Apr 2014 (holotype: CANB; isotype: NSW).

Thallus crustose, epilithic, determinate, areolate, pale greenish grey, 0.1–0.35(–0.45) mm thick, forming colonies to c. 4 cm wide; areoles angular, 0.3–1 mm wide, plane to slightly convex, smooth to irregularly and minutely uneven. Cortex poorly defined or distinct and 10–15(–20) µm thick, subtending a discontinuous, hyaline necral layer to 25 µm thick; cells rounded to ellipsoidal, 4–8 µm wide, thick-walled, the walls dark olive-brown towards the surface, hyaline within. Algal layer 60–160 µm thick, with a very uneven lower edge; cells green, chlorococcoid, broadly ellipsoid to globose, 7–13 µm wide. Medulla 80–200 µm thick, hyaline, incorporating minute rock fragments and crystals; hyphae 3–6 µm wide. Prothallus not apparent, or blackish, clearly delimiting the thallus and up to 0.5 mm wide. Apothecia numerous, usually solitary, superficial, constricted at the base, lecideine, (0.36–)0.55(–0.82) mm diam. [$n = 60$], not subtended by algae; disc epruinose or, more commonly, with a thick white pruina, becoming dull olive-green to greenish black, the colour unchanged when wetted or becoming slightly translucent, plane to slightly or strongly convex, smooth to minutely uneven; margin concolorous with the disc or slightly to considerably paler, epruinose, entire or irregularly and shallowly flexuous or crenate, 40–70 µm thick, scarcely prominent, persisting past maturity and less than 50 µm thick, or becoming excluded; in section the proper exciple is non-carbonized, 40–80 µm thick, annular, partially subtending but not continuous beneath the hypothecium, the outer edge medium to dark olive-brown, internally hyaline to pale greenish brown; external cells tightly packed, radiating, thicker-walled, 2–3 µm wide; internally with a comparatively loose, hyaline reticulum of radiating hyphae. Hypothecium hyaline, 60–100 µm thick, not inspersed with granules or globules, I– (with or without pretreatment in K), merging with the thalline medulla below. Hymenium 70–95 µm thick, not inspersed with oil droplets, granules or crystals, I– (after pretreatment in K), except for the persistently I+ deep blue ascus apices; epihymenial region a diffusely medium greenish brown layer 20–40 µm thick. Paraphyses rather tightly conglutinate in water, loosening in K, sparingly branched or unbranched below, repeatedly branching in the uppermost 20–30 µm; cells 2–3.5 µm wide, some but not all apical cells thicker-walled, more rounded, with dark capitate pigmentation and 4–5(–6) µm wide. Asci narrowly clavate to clavate-cylindrical, with 40–60(–80) ascospores, 58–72 × 14–18 µm, with a tapering stalk; apex rounded to somewhat truncate; submature asci with a thick uniformly amyloid tholus and a very distinct ocular chamber. Ascospores colourless, simple, elongate-ellipsoid to broadly ellipsoid, lacking a perispore, usually biguttulate, (6–)7.5(–9.5) × (3–)4(–5) µm [$n = 50$]. Pycnidia not seen.

Chemistry: sekikaic acid (major).

Species of *Sarcogyne* Flot. (Acarosporaceae) have a crustose, often immersed and usually inconspicuous thallus, reddish brown to black apothecia with a lecideine exciple, a non-carbonised epihymenium, simple to sparingly branched (but not anastomosing) paraphyses, and asci that usually contain (50–)100–200 simple hyaline ascospores (Magnusson 1935; Clauzade and Roux 1985; Knudsen and Standley 2007; Fletcher and Hawksworth 2009). Currently with almost 40 accepted species, it grows on calcareous and siliceous rocks mainly in temperate and semi-arid regions (especially in Europe, North Africa and North America), less commonly at subtropical, wet-tropical and subpolar latitudes.

The genus is poorly known in the Southern Hemisphere and where it has almost certainly been overlooked. Five species have been reported from Australia, viz. *S. clavus* (DC.) Kremp. and *S. hypophaea* (Nyl.) Arnold from the south-west of Western Australia, the rather common *S. regularis* Körb. from temperate latitudes, *S. iridana* P.M.McCarthy & Kantvilas from sandstone in central Australia and *S. meridionalis* P.M.McCarthy & Kantvilas from limestone, mainly in southern coastal and hinterland areas (McCarthy and Kantvilas 2013).



Fig. 2. *Sarcogyne sekikaica* (holotype). Scale: 1 mm.

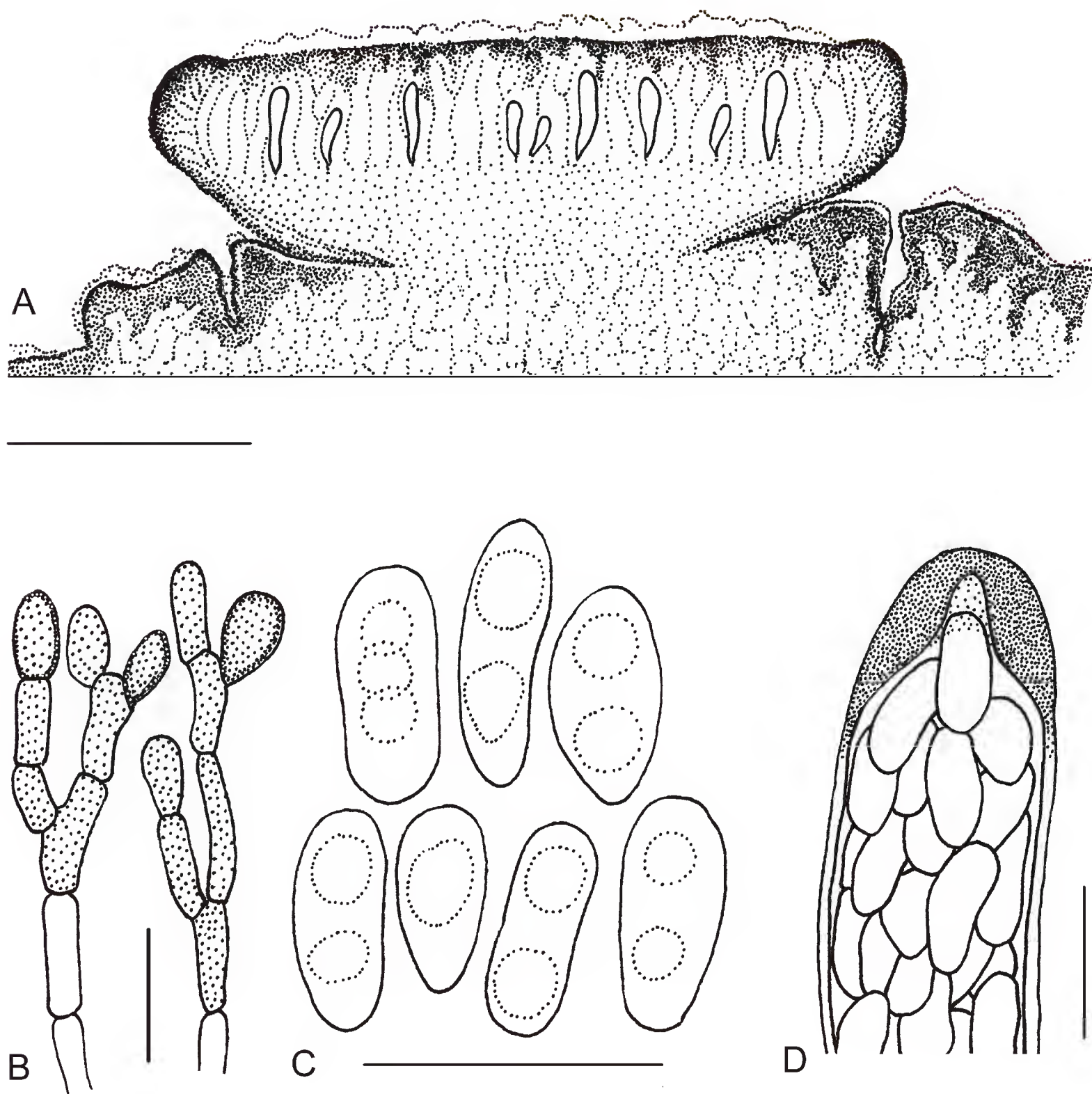


Fig. 3. *Sarcogyne sekikaica* (holotype). A, Sectioned apothecium and adjacent thallus (semi-schematic); B, Distal cells of paraphyses; C, Ascospores; D, Apex of submature ascus showing amyloid reaction of the tholus. Scales: A = 0.2 mm; B–D = 10 μ m.

Sarcogyne sekikaica is characterized by the rather thick areolate thallus containing a substantial concentration of sekikaic acid (secondary metabolites are absent in most *Sarcogyne* species and none have previously been found in Australian taxa), its occurrence on siliceous rock, moderately large, prominent apothecia commonly with a thick white pruina and a thin, non-carbonized exciple, distally branching paraphyses and comparatively large ascospores only 40–60(–80) per ascus.

The widespread *S. hypophaea* occurs on siliceous and calcareous rocks and has a very thin and inconspicuous thallus. Moreover, its epruinose apothecia have a plane, dark reddish disc, a thick and persistent, often jointed exciple, and asci with *c.* 100 ascospores, each $3.5\text{--}5 \times 1\text{--}2 \mu\text{m}$ (Knudsen and Standley 2007; Fletcher and Hawksworth 2009; Knudsen and Kocourcová 2011; Knudsen *et al.* 2013). The exclusively silicolous *S. clavus* also has a very thin thallus, much larger apothecia (usually to 3 mm wide) with a thicker, crenulate and carbonized exciple, a dark brown hypothecium and asci with at least 200 ascospores much smaller than those of *S. sekikaica* (Knudsen and Standley 2007; Fletcher and Hawksworth 2009). The predominantly silicolous *S. similis* H.Magn. (North America, the Mediterranean and southern Africa) has a variable thallus lacking secondary metabolites, larger and sometimes clustered apothecia, often with a thicker exciple, and clavate asci producing at least 100 smaller ascospores (Magnusson 1935; Knudsen and Standley 2007). Finally, *S. iridana*, from sandstone in central Australia, has a very thin, diffuse whitish thallus, prominent epruinose apothecia, unbranched paraphyses and 150–180-spored asci. A key to the six known Australian taxa is provided below.

Etymology: The specific epithet refers to the high concentration of the depside sekikaic acid in the thallus of the new species.

Distribution and habitat: *Sarcogyne sekikaica* is known only from a weathered outcrop of hard trachytic rhyolite in montane heath at 1250 m, below the summit of Mount Canobolas. This habitat supports a diverse saxicolous lichen flora including *Acarospora fuscata* (Nyl.) Arnold, *A. veronensis* A.Massal., *Aspicilia* spp., *Buellia homophylia* (C.Knight) Zahlbr., several *Caloplaca* spp., *Candelariella vitellina* (Hoffm.) Müll.Arg., *Ingvariella bispora* (Bagl.) Guderley & Lumbsch, *Lecidea capensis* Zahlbr., numerous Parmeliaceae, *Pertusaria* spp., *Parapropidia leptocarpa* (C.Bab. & Mitt.) Rambold & Hertel, *Ramboldia petraeoides* (Nyl. ex C.Bab. & Mitt.) Kantvilas & Elix, five species of *Rhizocarpon*, *Rinodina oxydata* (A.Massal.) A.Massal., *Tephromela atra* (Huds.) Hafellner and an undescribed species of *Buellia sens. lat.*

Key to *Sarcogyne* in Australia

- 1 Exciple carbonized 2
- 1: Exciple not carbonized 3
- 2 Apothecia 0.4–1 mm diam.; margin entire; hypothecium colourless to pale brown *S. hypophaea*
- 2: Apothecia 1–3 (–6) mm diam.; margin crenulate; hypothecium medium to dark brown *S. clavus*
- 3 Thallus on calcareous rock (limestone or mortar) 4
- 3: Thallus on siliceous rock (sandstone or rhyolite) 5
- 4 Apothecia 0.17–0.4 mm diam.; disc epruinose, concave to plane *S. meridionalis*
- 4: Apothecia 0.4–1.2 mm diam.; disc usually white- to blue-grey-pruinose, plane to convex *S. regularis*
- 5 Thallus whitish, diffuse, 0.015–0.025 mm thick, lacking secondary metabolites; apothecia epruinose; ascospores $3\text{--}7 \times 1.5\text{--}2.5 \mu\text{m}$, *c.* 150–180 per ascus *S. iridana*
- 5: Thallus greenish grey, areolate, 0.1–0.35 (–0.45) mm thick, containing sekikaic acid; apothecia pruinose or not; ascospores $6\text{--}9.5 \times 3\text{--}5 \mu\text{m}$, 40–60 (–80) per ascus *S. sekikaica*

References

- Anderson RH (1961) Introduction. Contribution from the New South Wales National Herbarium 19: back end paper.
- Clauzade G, Roux, C (1985) Likenoj de Okcidenta Europo. Ilustrita Determinlibro. *Bulletin de la Société Botanique du Centre-Ouest*, Nouvelle Série, Numéro Spécial 7: 1–893.
- Coppins BJ, Aptroot A (2008) New species and combinations in The Lichens of the British Isles. *Lichenologist* 40: 363–374. <http://dx.doi.org/10.1017/S0024282908008165>
- Elix JA, Ernst-Russell, KD (1993) *A Catalogue of Standardized Thin-Layer Chromatographic Data and Biosynthetic Relationships for Lichen Substances*, 2nd edn. (Australian National University, Canberra)
- Elix JA, Giralt M, Wardlaw JH (2003) New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1–7.
- Fletcher A, Hawksworth DL (2009) *Sarcogyne* Flot. (1851). Pp. 829–830 in Smith CW, Aptroot A, Coppins BJ, Fletcher A, Gilbert OL, James PW and Wolseley PA (eds), *The Lichens of Great Britain and Ireland*. (British Lichen Society: London)
- Henssen A, Lumbsch HT (1985) A new *Gyalideopsis* species from the subantarctic. *International Journal of Mycology and Lichenology* 2: 1–11.
- Jacobs SWL, Pickard J (1981) *Plants of New South Wales*. (D. West, Government Printer, Sydney)
- Kalb K, Vězda A (1988) Neue oder bemerkenswerte Arten der Flechtenfamilie Gomphillaceae in der Neotropis. *Bibliotheca Lichenologica* 29: 1–80.
- Knudsen K, Kocourková J (2011) Lichenological notes 3: *Sarcogyne plicata* in California. *Mycotaxon* 118: 423–431. <http://dx.doi.org/10.5248/118.423>
- Knudsen K, Kocourková J, Westberg W (2013) The identity of *Sarcogyne hypophaea* (Nyl.) Arnold. *Opuscula Philolichenum* 12: 23–26.
- Knudsen K, Standley SM (2007) *Sarcogyne*. Pp. 289–296 in Nash III TH, Gries C and Bungartz F (eds), *Lichen Flora of the Greater Sonoran Desert Region* 3. (Lichens Unlimited: Tempe, Arizona)
- Lücking R, Aptroot A, Umaña L, Chaves JL, Sipman HJM, Nelsen MP (2006) A first assessment of the Ticolichen biodiversity inventory in Costa Rica: the genus *Gyalideopsis* and its segregates (Ostropales: Gomphillaceae), with a world-wide key and name status checklist. *Lichenologist* 38: 131–160. <http://dx.doi.org/10.1017/S0024282905005657>
- Lücking R, Sérusiaux E, Vězda A (2005) Phylogeny and systematics of the lichen family Gomphillaceae (Ostropales) inferred from cladistic analysis of phenotype data. *Lichenologist* 37: 123–170. <http://dx.doi.org/10.1017/S0024282905014660>
- Magnusson AH (1935) Acarosporaceae, Thelocarpaceae. Pp. 1–318 in Rabenhorst GL, *Kryptogamen-Flora von Deutschland, Österreich, und der Schweiz*. Die Flechten, Abt. 5(1). (Gebrüder Borntraeger: Leipzig)
- McCarthy PM (2014) *Checklist of the Lichens of Australia and its Island Territories*. (Australian Biological Resources Study, Canberra; <http://www.anbg.gov.au/abrs/lichenlist/introduction.html>; Version 21 May 2014 (accessed: 24 May 2014)
- McCarthy PM, Kantvilas G (2013) Two new species of *Sarcogyne* (lichenised Ascomycota, Acarosporaceae) from central and southern Australia, *Journal of the Adelaide Botanic Garden* 26: 15–21.
- Vězda A (2003) *Gyalideopsis tuerkii* (lichenisierte Ascomycotina, Gomphillaceae), eine neue Art der Alpen. *Herzogia* 16: 35–40.